of cases, for the diseases which are spread by milk are frequently, and in fact generally, spread in other ways as well and the milk route of infection is not the only one to be guarded against.

The chart shown above illustrates the purpose of morbidity reports and their relation to the control of disease and the prevention of epidemics. That the securing of morbidity reports is attended in many diseases with considerable difficulty is true. This constitutes an obstacle in the control of many of the commoner communicable diseases, an obstacle, however, which health departments must solve and overcome if they are to continue to have a cause for being.

THE CHEMICAL DISINFECTION OF WATER.

By Earle B. Phelps, Professor of Chemistry, Hygienic Laboratory, United States Public Health Service.

The chemical disinfection of water supplies has come into such general use that there can no longer be any doubt of its practical value. Most of the large cities of the country and hundreds of smaller communities are now using the disinfection process with entire satisfaction. It is so economical and so simple to install and to operate and furnishes such assurance of freedom from water-borne infection that its use should be encouraged whenever there is any possible doubt as to the sanitary character of the water supply.

There are few untreated water supplies in the United States to-day, except those taken from wells, which are so well protected that they do not at times show evidences of pollution. Whether the pollution is only remote and occasional or whether it is continual but only slight in amount, the installation of a disinfecting plant for continuous use or for use during danger periods represents a cheap insurance against epidemics. As an adjunct to filtration it furnishes an additional safeguard against occasional failure and often permits more rapid rates of filtration and important economies in the use of chemicals and in other ways.

Of the various agencies that have been proposed for the chemical disinfection of water only three—ozone, hypochlorite of calcium, and gaseous chlorine—have thus far proven satisfactory.

Ozone has had an extensive development in Europe and will undoubtedly be more widely used as the electrical and mechanical features of the process are better understood and worked out. It is undoubtedly efficient when properly applied, but mechanical imperfections and the high cost of operation have thus far delayed its adoption in this country.

The gaseous chlorine process is of recent introduction and as yet is not generally known. It is covered by general process patents, and

the various mechanical devices necessary in its application are likewise controlled by a few companies engaged in installing plants. Although there is but little published information upon its use, the indications are that it is cheap and efficient.

The hypochlorite process is in quite general use throughout the cities of the United States. The chemical, calcium hypochlorite, or, commercially, "bleaching powder" or "chloride of lime," is an active disinfectant even when highly diluted.

The proper application to a water of the requisite quantities of this disinfectant will bring about a practically complete removal of pathogenic organisms without affecting the water to any noticeable extent. The disinfectant later undergoes a chemical change whereby it is converted into perfectly harmless substances normally present in most natural waters. To secure this result, however, it is necessary to apply the proper quantity of disinfectant in the proper way. Too little hypochlorite gives imperfect disinfection, while an excess will produce an unpleasant taste in the water. If the flow of water by the point of application is subject to wide fluctuations, some adjustment of the rate of application is necessary. Finally most waters undergo seasonal changes in their chemical composition and accordingly require a variation in the dosage, the latter being determined to a large extent by the chemical character of the water.

In any important installation the services of a qualified expert who has had experience in this particular line are almost indispensable. It is his duty to design durable and workable apparatus, adjusted to the particular supply in question; to determine the proper point and mode of application to the water; to study the characteristics of the water and determine the proper normal dosage, and the daily and seasonal variation from the normal; and, finally, to control the operation by bacterial and chemical tests and to establish simple working rules and tests by which the untrained attendant will be enabled to produce good results.

In so far as it is possible to formulate these various matters in general terms, plans and directions for small hypochlorite installations will be given here. It is hoped thereby to encourage the use of hypochlorite whenever it is needed and especially among those smaller communities where the services of an expert may not be available. Such services, however, will usually be found to be cheapest in the end and should be secured whenever possible.

Bleaching powder is obtained commercially in iron drums weighing from 500 to 800 pounds net. It should be bought on specification to contain not less than 33 per cent available chlorine, and an occasional sample should be submitted to a chemist for analysis. Market prices range about $1\frac{1}{4}$ to $1\frac{3}{4}$ cents per pound, plus freight

from Buffalo or Philadelphia. The American (electrolytic) product is less likely to give troublesome odors to the water than the imported product which usually comes in wooden hogsheads.

The minimum quantity of solution which can be properly controlled and measured is about 15 gallons per hour or 350 gallons if the plant is to run 24 hours without attention. A pair of concrete tanks each having a capacity of one day's supply makes a desirable arrangement. These may conveniently be 3 by 4 feet by 4 feet deep or 4 by 4 feet by 3 feet deep, inside and to the flow line or water level. These tanks will be designated the solution tanks.

In emergencies or when economy or other requirement makes it desirable, a set of six or seven vinegar barrels, properly connected with galvanized iron piping, makes a satisfactory temporary plant. They should be well painted on the outside with asphaltum or some good mineral paint.

At some higher elevation, so that its contents will flow by gravity into the solution tanks, a mixing tank is necessary for mixing the bleach with water. This may have a capacity of not less than 25 to 35 gallons for small plants and of 2.5 gallons per pound of bleaching powder for larger installations. It may, of course, be used twice a day so that a 35-gallon tank could handle 28 pounds per day, but this will double the labor charge. For small plants hand mixing is satisfactory. The solution in the mixing tank is allowed to stand four hours or longer and may then be drawn off into the solution tanks, where it is diluted to the proper strength. It is best to provide a space in the mixing tank for the insoluble sludge that remains so that only the clear supernatant solution is drawn off. A blow-off at the bottom provides means for emptying this sludge to the sewer or of disposing of it otherwise.

Regulating the Dose.

A constant rate of dosage is maintained by discharging through an orifice, pipe, or other fixed opening under a constant head or level. Variation in the rate may be obtained by varying the level or by increasing the size of the orifice.

As the level in the solution tanks undergoes continuous change a constant level device is essential. Satisfactory devices of this character and made of suitable material resistant to the strong hypochlorite solution are obtainable on the market. One such device which is both simple and serviceable is shown in figure 1. It is made wholly of vulcanite and glass. For emergency and temporary use an ordinary toilet flush tank with ball-cock regulator is satisfactory.

A lead-lined tank with glass ball and bronze valve parts will give fair service for some time. A still more simple device is shown in

figure 2. A piece of lead pipe of quarter inch inside diameter serves as feed pipe. To its down-turned end is attached a flexible rubber tubing, the other end of which is supported by a wooden or glass float. (An electric bulb makes an excellent float.) The tube is so adjusted that at the proper water level it is kinked and the supply cut off.

A suitable orifice for regulating and varying the rate of flow may be made of hard rubber, glass, or other resistant material. The most satisfactory apparatus is one in which an opening moves over a long wedge-shaped slot in such a way that the area of effective opening is increased or decreased. Such an apparatus, properly graduated, is capable of delivering solution at any required rate and is almost necessary for the proper control of the plant. A similar result is obtained by varying the level in the orifice box, over an orifice of constant size; or two or three replaceable orifices of various sizes may be used in conjunction with the variable head feature. This is more complicated and more liable to error in manipulation.

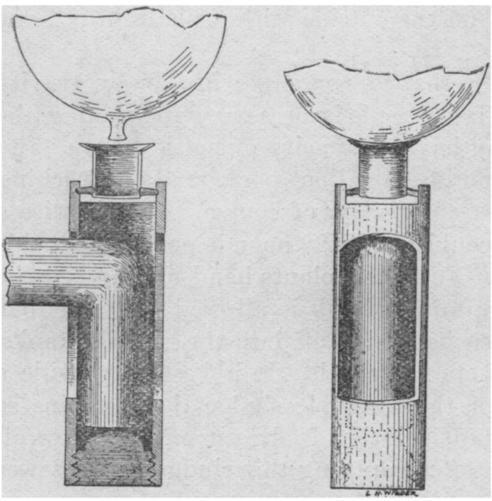

FIG. 1.—Cross sectional and perspective view of automatic constant level regulator valve.

Any druggist can construct a simple glass siphon of glass tubing drawn out at the end to a small opening. Save for the danger of breakage this makes a very good orifice. (See fig. 2.) The effective working head is measured from the end of the outer arm, vertically to the water level in the box. If the tube be supported with a clamp so that vertical adjustment is possible the working head and consequently the rate of flow can be adjusted at will. Doubling the head over any orifice device increases the flow in the ratio 1:1.4. To double the rate of flow increase the head four times.

Addition of Disinfectant on "Constant-Strength" Plan.

Small plants are most easily run on the "constant-strength" basis, as this permits the simplest control and can be intrusted to any intelligent attendant. Suppose, for example, the consumption is 1,000,000 gallons per day and this supply is pumped at a regular rate of 100,000 gallons per hour for 10 hours. The solution will be made

up at a strength of 1,000 parts of available chlorine per million parts of water or 1:1,000. If this be added at a rate of 15 gallons per hour it is diluted in the 100,000 gallons of water in the ratio of 15:100,000 or 150:1,000,000. Since the solution is 1:1,000, the water is then being treated at a rate of 0.15 parts of available chlorine per million. Twenty gallons of solution per hour gives 0.2 parts, 30 gallons 0.3 parts, etc.

To obtain the initial solution of required strength a much stronger solution is made up in the small mixing (upper) tank and allowed to settle. This solution is then tested chemically or by a special hydrometer, which can be obtained in the market, giving readings directly in terms of available chlorine in parts per thousand. This test gives a measure of the amount of strong solution to be diluted into a full solution tank to give a solution containing 1,000 parts chlorine per million of water. Thus if the test shows 15 parts per thousand and the solution tank holds 350 gallons, 23.4 gallons of strong solution are run off and diluted to 350. The quantities in gallons corresponding to given strengths of solution may be tabulated for use by the attendant or they may be actually laid off on a yardstick or wall float gauge so that for a strength of 14 the attendant merely draws down the strong solution to 14 on the gauge, this being equivalent to 23.4 gallons.

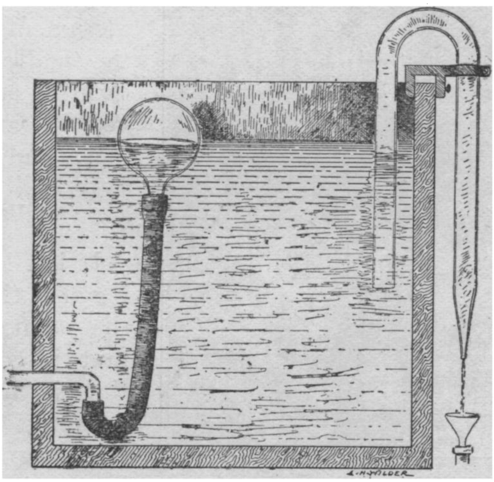

FIG. 2.—Sectional view of homemade regulator valve and orifice device.

Amount of Disinfectant Necessary.

Thus far attention has been given to preparing and measuring the disinfectant solution. The amount actually necessary for disinfection is finally controlled by modifying the rate of flow at the orifice. The amount necessary can be determined by the expert from a study of the water. Otherwise it is largely a matter of experiment. A few general instructions may be given.

On the basis of 33 per cent bleaching powder (which allows for losses in extraction) 25 pounds per million gallons of water will give one part per million of available chlorine. Clear colorless ground

water, free from iron, or the clear water of large lakes requires as a rule from 0.1 to 0.3 parts of chlorine or 2.5 to 7.5 pounds of bleaching powder per million gallons. Mountain streams and upland water free from color and turbidity and without storage in ponds require from 0.2 to 0.5 parts. Colored river waters, swamp waters, and highly polluted surface waters may require as much as one part or more.

Contrary to expectation waters requiring a moderately large amount of disinfectant are most easily handled. This is because the reaction is rapidly completed and the excess disinfectant eliminated by the organic matter. Very pure water, organically (lakes and springs), react slowly, require more time for the completion of the disinfection (owing to the smaller dosage), and require more careful supervision to prevent overdosage and consequent unpleasant tastes and odors.

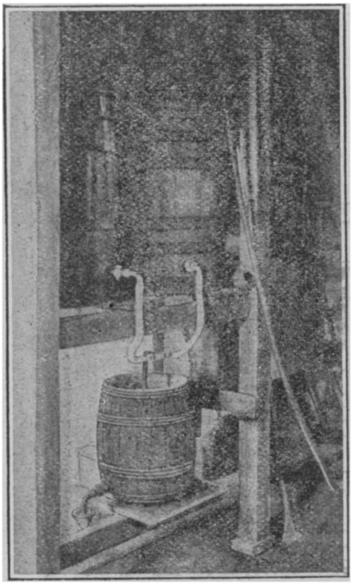

Fig. 3.—Emergency hypochlorite plant installed by Mr. H. P. Letton, U. S. Public Health Service (then assistant engineer, New Jersey State Board of Health). This plant was put in in one day. The mixing tank (a third barrel above the other two) does not show. The constant level device shown in Fig. 2 was used, and the orifice is an ordinary water cock.

Variable Flow Systems.

It has been assumed in the foregoing that the rate of flow of water past the point of application of disinfectant is constant. In most instances this is not the case. Even where pumping is resorted to, the rate of pumping varies from hour to hour. In gravity systems the flow fluctuates with the demand from almost nothing, in the night, to a maximum in the morning hours. It is obvious that the disinfectant must be applied at a proportionate rate for the best results.

In the case of pumping plants the orifice may be regulated to compare with the pump revolutions, a table of comparative values being prepared for the engineer's use, or a small chemical pump may be connected by belt to the main pump system so that the two are always proportional. This constant proportion, however, does not permit of the "constant-strength" method of making the solution, unless some other factor, i. e., length of feed-pump stroke, be made adjustable. With a variable-strength solution made up from day to day of a strength corresponding to the required dose, a proportionate

rate of pumping is satisfactory. If Venturi or other meters are in use, the meter reading may be made the basis for adjustment.

In gravity systems, where the fluctuations are greatest, the greatest difficulty arises. There is no simple method of adjusting the rate of dosage to the flow in such cases. Certain mechanical devices are obtainable for accomplishing this result and should be used whenever possible.

Desirable and even necessary as many of these requirements are it can not be too strongly emphasized that much can be accomplished in a short time and by simple home-made means.

A few barrels, some piping, a toilet flush tank, and some bleaching powder are all that are absolutely required. Pending the installation of a better plant, the water supply of any community can be absolutely safeguarded within a few hours after beginning work. These may be called the "first-aid" remedies, after which the question of securing the services of an experienced water-works engineer should properly come up for consideration.

THE SOURCE AND SUPPLY OF MEDICINES.

WITH SPECIAL REFERENCE TO THE INTERFERENCE CAUSED BY THE EXISTING EUROPEAN WAR.

By Martin I. Wilbert, Technical Assistant, Division of Pharmacology, Hygienic Laboratory, United States Public Health Service.

The European war has demonstrated as no other combination of circumstances possibly could the degree to which we in this country are dependent on Europe for the ordinary supplies of our drugs and medicines. This dependence has been particularly emphasized by the unprecedented increase in the price of some of the more widely used drugs and the practical exhaustion for the time being of some few of the more important articles of materia medica that are made or controlled in the European countries now at war.

Probably the chief reason for the rapid rise in values was the fact that the available stocks of many of the staple articles during the summer months are usually at a rather low level and that practically all of the great drug markets of the world are in the war zone, so that stocks on hand in these ports are not available for export, either because of blockade or because the local government has interdicted the exporting of drugs.

It is not generally known that by far the greater number of drugs sold in the different countries of the world are marketed through London, Hamburg, or Trieste. A few drugs, like the products of the Dutch colonies, are marketed through Amsterdam, and some of the